

## 6.1.2 CALIBRATION

To calibrate a thermometer, instrument readings are checked across a range of temperatures against those of a thermometer of certified accuracy.

Calibrate liquid-in-glass and thermistor thermometers in the office at regularly scheduled intervals. **Tag acceptable thermometers with date of calibration.**

### *Minimum calibration requirements*

- ▶ **Liquid-in-glass thermometer:**
  - Every 3 to 6 months, using a 2-point calibration, and
  - Annually, using a 3-point calibration.
- ▶ **Thermistor thermometer:**
  - Every 3 to 4 months, check calibration
  - Annually, using a 5-point calibration.
- ▶ The standard thermometer against which all other thermometers are calibrated must be certified by the National Institute of Standards and Technology (NIST). It must be accurate to 0.1°C.

Check the certificate of calibration for the NIST thermometer before calibrating field thermometers. **NIST-certified thermometers are not for field use.**

Thermometers being calibrated must meet NIST specifications to a minimum of three temperatures at approximately 0°, 25°, and 40°C. Thermistors must be calibrated at 5 points within this range. If environmental water or air temperatures will fall below 0°C or rise above 40°C, add additional calibration points to bracket the temperatures to be measured.

**Field checking thermometer calibration by comparing readings with another field thermometer does not substitute for required laboratory calibration procedures. When measuring water temperature in the laboratory:**

- ▶ Submerge the bulb and liquid column of the total-immersion thermometer.
- ▶ Keep the NIST-certified thermometer and the thermistor sensor submerged in the container throughout calibration.

- ▶ Read the NIST-certified thermometer and record the thermistor readings throughout warming and cooling periods.
- ▶ Check the meter batteries periodically for proper voltage.
- ▶ Record the calibration data in the instrument log book for each thermistor thermometer, noting if a sensor has been replaced.

***If using a commercial refrigerated water bath:***

1. Precool the sensor of the thermometer being tested (test thermometer) to 0°C by immersing it in a separate ice/water bath.
2. Immerse the test and NIST-certified thermometer sensors in the refrigerated bath with a water temperature of approximately 0°C.
3. Position the thermometer sensor(s) so that they are properly immersed and so that the scales can be read. Stir the water bath and allow at least 2 minutes for the thermometer readings to stabilize.
4. Without removing the thermometer sensor from the refrigerated water bath, read the test thermometer(s) to the nearest graduation (0.1 to 0.5°C) and the NIST-certified thermometer to the nearest 0.1°C.
  - Take three readings within a 5-minute span for each thermometer.
  - Calculate the mean of the three temperature readings for each thermometer and compare its mean value with the NIST-certified thermometer.
  - If the liquid-filled test thermometer is found to be within  $\pm 1$  percent of full scale or  $\pm 0.5^\circ\text{C}$  of the NIST-certified thermometer, whichever is less, set it aside for calibration checks at higher temperatures.
  - If the test thermistor is found to be within  $\pm 0.2^\circ\text{C}$  of the NIST-certified thermometer, set it aside for calibration checks at higher temperatures.
5. Repeat steps 1–3 in 25°C and 40°C water. Keep the bath temperature constant. Check the thermistors at two or more additional intermediate temperatures (for example, 15°C and 30°C).
6. Tag acceptable thermometers as “District certified” with calibration date and certifier’s initials.

***If a commercial refrigerated water bath is not available:***

1. Freeze several ice cube trays filled with deionized water.
2. Fill a 1,000-mL plastic beaker or Dewar flask three-fourths full of crushed, deionized ice. Add chilled, deionized water to the beaker. Place the beaker of ice/water mixture in a larger, insulated container or Dewar flask. Place the NIST-certified thermometer into the ice/water mixture and make sure that the temperature is uniform at 0°C by stirring and checking at several locations.
3. Precool the test thermometer sensor to 0°C by immersing it in a separate ice/water bath.
4. Add the test thermometer sensor(s) to the ice/water mixture. Position the sensor(s) so that they are properly immersed and so that the scales can be read. Periodically stir the ice/water mixture and allow at least 2 minutes for the thermometer readings to stabilize.
5. When the readings stabilize, compare the temperature of one test thermometer at a time with that of the NIST-certified thermometer. Without removing the temperature sensor(s) from the test bath, read the test thermometer(s) to the nearest graduation (0.1 to 0.5°C) and the NIST-certified thermometer to the nearest 0.1°C.
  - Take three readings for each thermometer within a 5-minute span.
  - Calculate the mean of the three temperature readings for each thermometer and compare its mean value with the NIST thermometer.
  - If the test liquid-filled thermometer is found to be within  $\pm 1$  percent of full scale or  $\pm 0.5^\circ\text{C}$  of the NIST-certified thermometer, whichever is less, set it aside for calibration checks at higher temperatures.
  - If the test thermistor is found to be within  $\pm 0.2^\circ\text{C}$  of the NIST-certified thermometer, set it aside for calibration checks at higher temperatures.
6. For "room temperature" calibration (about 25°C), place a Dewar flask or container filled with about 1 gallon of water in a box filled with packing insulation. (A partially filled insulated ice chest can be used for multiparameter instruments.) Place the calibration container in an area of the room where the temperature is fairly constant (areas away from drafts, vents, windows, and harsh lights).

7. Properly immerse the NIST-certified and test thermometer sensor(s) in the water. Cover the container and allow the water bath and thermometers to equilibrate. Stir the water and check every couple of hours for temperature uniformity using the NIST-certified thermometer—it may be necessary to let the bath equilibrate overnight.
8. Compare one test thermometer at a time with the NIST-certified thermometer. Calibrate as described in step 5 above.
  - For greater than 25°C temperature calibration, place a beaker (1,000 mL or more) of warm water (about 40°C) on a magnetic stirrer plate and repeat procedure as described in step 5 above.
  - Tag acceptable thermometers as “District certified” with calibration date and certifier’s initials.

Corrections can be applied to measurements made with a thermistor instrument system if necessary, using a calibration curve or table plotted in the log book. **Thermometers found to be out of calibration by more than 0.2°C must be recalibrated per manufacturer’s instructions or returned to the manufacturer for proper calibration and (or) repairs.**

Thermistors included in other field-measurement instruments must be calibrated routinely. Accurate determination of other field measurements depends on accurate temperature measurements. This must be underscored for thermistors incorporated in specific electrical conductance, dissolved-oxygen, and pH instruments, because these thermistors are used for automatic temperature compensation of the measurement being made.

Tag and date acceptable thermometers.